A Brief History of Outside Plant Design

1. The term "outside plant" refers to all physical telecommunications facilities located outside of central office buildings, normally consisting of poles, conduit, fiber optic cable, copper cable, and ancillary equipment. Issues surrounding outside plant form the basis for the majority of unresolved concerns in this case.

2. Engineering design must take into account transmission characteristics of copper cable. Customers are lumped into geographical groupings, and then a fail-safe transmission design is created for all customers in that grouping, using the worst case loop. This simplifies distribution network design. (*See* Bellcore, *Telecommunications Transmission Engineering*, 1990, p. 91.) Such a grouping of customers is normally referred to as a *Distribution Area*. All cables within a Distribution Area should have a uniform cable gauge makeup and loading characteristics. (Load coils are inductors placed on copper cable wires to counteract the effects of increasing capacitance as pair lengths become longer.) This traditional simplified engineering planning and design method, also known as "prescription design," has been used for decades to preclude the engineer from having to do a manual loop qualification for each individual loop within the Distribution Area.

3. Over many years, several distribution network designs have evolved. The major distribution network designs that evolved are *Multiple Plant*, *Dedicated*

Plant, *Interfaced Plant*, the *Serving Area Concept* ("*SAC Design*"), and the *Carrier Serving Area Concept* ("*CSA design*"). Network design has evolved such that CLECs can provide either advanced or analog services over the vast majority of existing outside plant.

4. *Multiple Plant* (pre-1960s): *Multiple Plant* design dates back to the days of party line service. While there are still some customer lines on party line service, the industry has long recognized that party line service should have been eliminated years ago in order to provide equivalent service levels to all end users of POTS common carrier service. This very old design created many cases of "bridged tap."

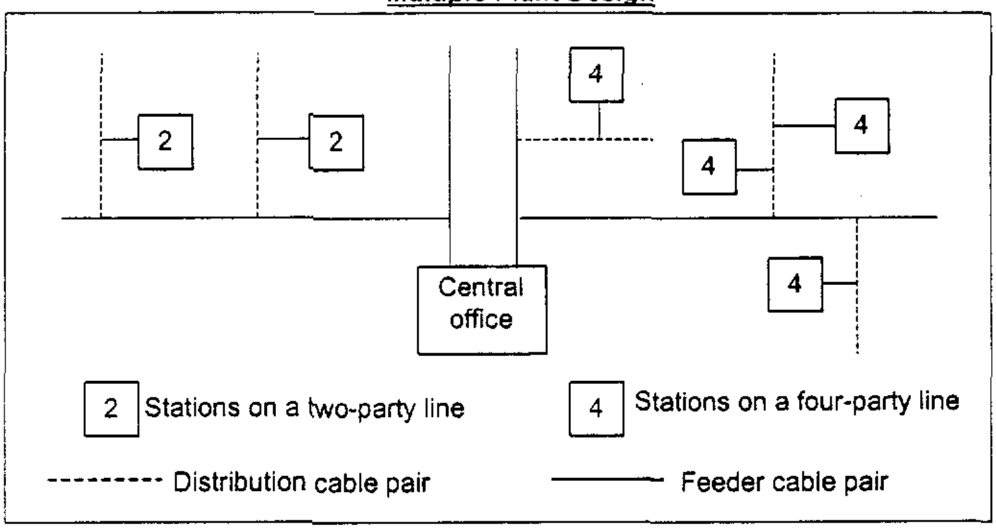
5. *Bridged tap* is defined as follows:

> Bridged tap [occurs when] an extra pair of wires [is] connected in shunt [parallel] to a main cable pair. The extra pair is normally open circuited but may be used at a future time to connect the main pair to a new customer. Short bridged taps do not effect voice frequency signals but can be extremely detrimental to high frequency digital signals. (Gilbert Held, *Dictionary of Communications Technology*, John Wiley & Sons 1995, p. 56.)

6. *Bridged tap* was initially used so that telephone companies could provide facilities less expensively in a market where not all customers would want telephone service. Since an exact customer requesting dial tone, among several, could not be predicted, use of bridged tap allowed the company to draw dial tone on one pair of wires at several locations. That outdated environment produced a design concept called "multiple plant." *Multiple plant* is defined as follows:

> Multiple plant design involves splicing two or more distribution pairs to a single feeder pair, as illustrated [below]. That is, feeder and distribution plant are combined with no interface between them. This procedure provides flexibility to accommodate future assignments by providing multiple appearances of the same loop pair at several distribution points. In times when multiparty service was common, it accommodated field-bridging of party-line stations, saving feeder pairs at the cost of added field work for rearrangements. However, adding new feeder pairs forced line and station transfers to relieve the distribution cables. Because changing existing plant or adding new facilities is labor intensive and because party-line service continues to shrink, multipled plant design has been largely replaced by other designs. (Bellcore, *Telecommunications Transmission Engineering*, 1990, p. 92.)

Multiple Plant Design



7. *Dedicated Plant* (late 1960s): *Dedicated plant* was a short-lived attempt to provide a permanently assigned cable pair from the central office main distributing frame ("MDF") to each customer's Network Interface, without a Feeder Distribution Interface. This resulted in little network flexibility, and created maintenance problems. "... [D]edicated plant has been superseded by

interfaced plant." (Bellcore, *Telecommunications Transmission Engineering*, 1990, p. 92.)

8. *Interfaced Plant* (1960 - 1972): *Interfaced plant* design guidelines mandated the use of a Feeder Distribution Interface ("FDI"),

> a manual cross-connection and demarcation point between feeder and distribution plant.
>
> Compared to multipled and dedicated plant, interfaced plant provides greater flexibility in the network. The serving area concept, discussed below, uses the interfaced plant design. (Bellcore, *Telecommunications Transmission Engineering*, 1990, pp. 92-93.)

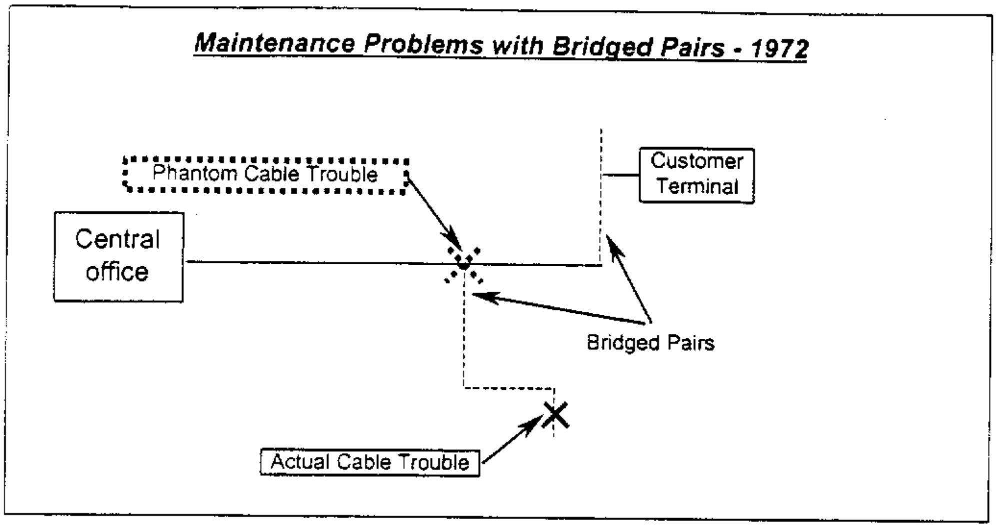
9. *Serving Area Concept* (1972 - 1980+): The *Serving Area Concept* ("*SAC*") design was introduced in the early 1970s as a prescription simplified engineering planning and design method, and was the first major attempt to modernize the network to care for growing and ubiquitous service to an ever shifting customer base. Many concepts carried over into the *Carrier Serving Area* ("*CSA*") design guidelines that have been used since approximately 1980. The following are important aspects of *SAC* design that form the basis for the modern day concept of outside plant planning and design that have been in place for over 27 years:

> Portions of the geographic area of a wire center are divided into discrete serving areas...
>
> The outside plant within the serving area is the distribution network. It is connected to the feeder network at a single interconnection point, the serving area interface [or feeder distribution interface].

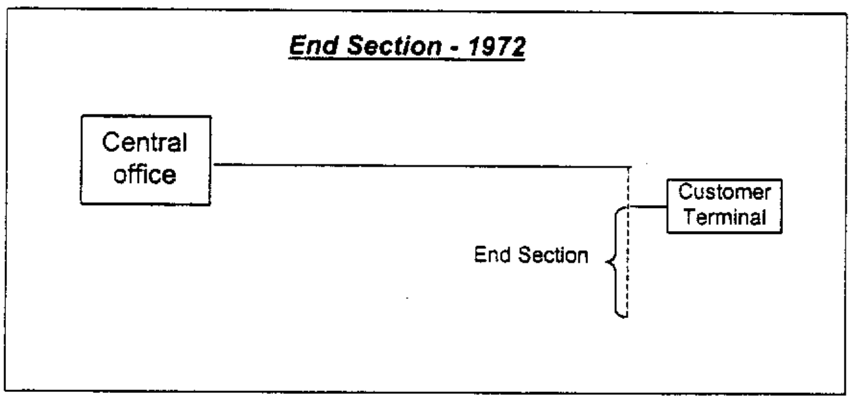
> … it simplifies and reduces engineering and plant records necessary to design, construct, administer, and maintain outside plant…
>
> **It aids transmission by minimizing bridged taps**, a distinct advantage in providing services of bandwidth greater than voice. (Bellcore, *Telecommunications Transmission Engineering*, 1990, pp. 92-93, emphasis added.)

The *SAC* concept also stated that there should be no multipled copper feeder cable (i.e., no bridged tap at all in copper feeder plant), no multipled copper cable binder groups between distribution cable side legs (i.e., no bridged tap at all in copper distribution plant), and that a primary and secondary copper distribution pair would be dedicated to a customer's block terminal, with those pairs cut dead beyond the serving terminal (i.e., no bridged tap in the form of "end section" for at least 2 pairs per living unit).

Another reason for eliminating all *bridged taps* from distribution side legs involved the ability to locate cable troubles. Where a single cable pair appeared in two different side legs, if there was a cable trouble off of the direct route back to the central office, in the side leg nearer to the central office, test measurements using a Wheatstone Bridge would indicate that the trouble was at the bridged tap splice, not at the actual trouble location. The following diagram illustrates the problem with *bridged taps* on distribution side legs:



Whereas the previous diagram illustrates the maintenance reasons for eliminating bridged tap between a customer and the central office, the following diagram shows the existence of end section, which is electrically similar, but is bridged in parallel with the working line, going away from the customer's location, rather than between the customer and the central office.



An end section should not be longer than 2,000 feet, thereby meeting the 1980 CSA design criteria that the industry has generally adopted. This end section should occur only for the rare occasion when the xDSL line is the third line to this customer, since the primary and secondary pairs should have been cut off at the serving terminal.

Carrier Serving Area (1980+): The next guideline for modernizing the network was the introduction of the "*Carrier Serving Area Concept*" to care for customers' demand for increasing transmission bandwidth. This new *CSA* prescription simplified engineering planning and design guideline initially used a simple 900 ohm rule that could be equated to loop lengths depending on wire gauge. The following Bellcore description indicates precisely the loops desired by service providers in provisioning xDSL loops of any kind currently in the marketplace:

> The maximum allowable bridged-tap is 2.5 kft, with no single bridged-tap longer than 2.0 kft. All CSA loops must be unloaded and should not consist of more than two gauges of cable. (Bellcore, *Bellcore Notes on the Networks - Issue 3*, December 1997, p. 12-5.)

10. Summary: What we have is a history clearly stating that all loops since 1980 should have been designed to the *CSA* concept that would support sought-after digital services. All loops since 1972 should have at least been designed under the *Serving Area Concept*, in which all distribution cable, within an entire *Distribution Area*, has the same transmission characteristics (all loaded or all non-loaded), all of the same copper gauge cable, and with no bridged tap. Therefore, correctly designed outside plant for the past 27 years should

present little problem to CLECs applying for xDSL service loops. Loops older than 27 years are far beyond their useful service lives and depreciation lives.

11. It should be noted that xDSL technologies were created under the vision that most existing copper circuits would support much higher bandwidth using sophisticated electronics. The legacy of that position goes back to the promulgation of CSA guidelines in 1980. Thus, most loops in an ILEC's outside plant inventory can support DSL and voice service because network design has evolved such that CLECs can provide either advanced or analog services over the majority of existing outside plant. CLECs just want a normal, well-designed copper loop. CLECs are not requesting a host of "unusual loops" or "unique loops" that justify the imposition of "unusual" and "unique" special charges.